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PRELIMINARY SURVEY OF WANDERING SPIDERS OF A MIXED CONIFEROUS FOREST

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ABSTRACT

This study of nomadic riparian ground-surface inhabiting spiders was made at the Los Alamos National Environmental Park, Mew Mexico. Spiders constituted about 10% of this mixed coniferous forest community. They were widely distributed in all samples, as the frequency of occurrence was high (mean for year was 85%). The mean relative densities of spiders, however, was low, ranging from less than 2% in winter to about 15% in summer. There is a seasonal shift of relative densities indicating that this population of carnivores may increase proportionately faster than its prey from winter to summer. Actual numbers of spiders trapped seasonally ranged from 102 individuals at all sites in late winter to over ten times as many (1140) in early summer. This mean number of species per season per site ranged from eight in winter to nearly 22 in early summer. The four sites were not significantly different from each other in total number or mean number of species, number of individuals or relative densities. Only frequencies show any differences and as indicated they are suspect especially in this preliminary study where samples are shown to be inadequate in most cases in numbers and length of time in operation.

INTRODUCTION

This study was part of a more extensive pitfall sampling of the wandering invertebrates of the ground surface in a streamside coniferous forest community. The sites sampled were located in Mortandad canyon at the Los Alamos National Laboratory in New Mexico. The study of spiders was made to determine what the species and populations of spiders were, what their relative abundances were, their abundances relative to all other invertebrates at the sites, what the seasonal and habitat preferences were and whether there was a single or more than one community in the transect studied and what modifications of techniques might be done to more accurately and definitely assess the characteristics of the spider community (ies). It was a preliminary study in the National Environmental Research Park. Four sites were sampled. The site at the highest altitude (site I) had constantly running water but no radionuclide contamination from fluid radioactive wastes whereas the other sites had varying degrees of minor contamination. An assessment of the affects of the radionuclide contamination was also an object of the study. Trapping was done at five different times of the year (late winter, midspring, early

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summer, midsummer and midfall), based on manpower, climatic and other mainly practical considerations.

This part of the study analyzes the spider portion of the carnivore trophic level. Only part of the ground inhabitants were sampled; the mobile portion. It did not include all spiders of the ground surface. Many of the web builders, none of the less mobile spiders, often only one sex, and often none of the immature portion were collected. Pitfall samples are selective and need to be supplemented by quadrat or "zeitfang" (equal effort) samples to census all of the ground dwelling spiders.

MATERIALS AND METHODS

Site Descriptions.—Four sets of ten pitfalls each were placed along the upper elevations (about 2200 m) of Mortandad Canyon. Each site was located 1000 m down the canyon from the previous site. Traps were ten meters apart alongside the meanderings of the stream. Elevation differences between sites were slight, ranging from 5 to 75 m. These four sites appeared different enough to be different communities.

The canyon extends mainly from west to east and empties into the Rio Grande, although only severe flash floods actually drain any water into the river. More detailed descriptions of the soils, contamination, etc. of the canyon are available elsewhere (Hakonson et al. 1973; Miera et al. 1977). The features of the sites which seem to be important are summarized in Table 1.

The canyon was a dry canyon which had water in it only at periods of rainfall. Over 15 years ago a cooling tower was installed at the head of the canyon and began releasing water into the streambed. Later, liquid effluent from a disposal plant began to be released into the stream about 100 m below the cooling tower. This is released suddenly, creating a rush of water at Site II which continued for as long as half an hour once or twice a day, except on weekends. Aquatic forms occur in the stream, and waterside spiders have become established. Site III commonly is affected by the daily surge of water although even here its onset is quite gentle. The traps at the sites, however, are set 6-9 cm above the stream channel and hence are not directly subjected to the effects of the surge. Site IV seldom receives water from the liquid disposal. The water has usually sunk into the ground somewhere in Site III. Summer storms still occasionally flood this part of the streambed.

As may be seen from these descriptions each site differs in several features although most of them are not sharp and distinct either quantitatively or qualitatively. Absolute differences occur between Sites I and IV, mainly in some plant occurrences, probably in soil moisture, soil texture and chemical composition (although not measured), winter and summer precipitation and streamside slope. However, no close correlation with any of these features has been made with the spider species occurring at each site. Generally, shade, soil moisture and density of vegetation is highest at Site I and least at Site IV. The canyon floor is greatest in area at Site IV and much more dry, level, and sandy than at Site I, where there is more humus but a much smaller and more rocky and irregular surface.

Methods.—A pitfall trap was designed so that it could be placed in position and easily removed with only slightly disturbing the vegetation and soil surface.

Alcohol (75% ethanol) was placed in the bottom to preserve the trapped animals. Pitfalls were placed in position in the morning and collected one to five days later, again in the morning. Initial trapping (midsummer and midfall) varied in duration, as indicated,

Table 1.–Characters of invertebrate trapping sites in Mortandad Canyon.

SITE	I	II	III	IV
Mean elevation	2190 m	2165 m	2090 m	2085 m
Rainfall Aug. 1975-Aug. 1976	42.5 cm	41.3 cm	43.6 cm	38.9 cm
Water flow of stream	constantly running water up to 25 cm deep in places	constantly running water with periodic surges of greater volume	usually daily surges of water with no flow in between	seldom any water except during rainstorm
Winter - water and snow	heavy snow cover surface stream water frozen most of winter	heavy snow cover water usually frozen	light snow cover heavy - up to 0.5 m deep ice	mostly snow and water free except for short period after storms
Insolation	sun irregular - much ground surface in shade	same or less sun reaching ground mostly sun flecked	some direct sun - ground mostly in shade except at midday	direct sun on ground much of day limited sun in late afternoon
Soil	moist to wet and marshy with much humus and few dry areas	moist to dry with humus and much sand	moist to dry with sand and much less humus	usually dry - sandy with least humus of all sites
Slope of stream	stream dropping most steeply of all sites	stream slope much less than I	less slope but much like IV	hardly any slope to stream
Stream banks	scarcely any banks pitfalls about same level as stream	streambed sides steep and up to 2 m deep abrupt drop to streambed	banks quite steep but less than 1 m deep. Abrupt drop to streambed.	banks shallow and less than 0.5 m deep and sloping to streambed
Streamside dominant plants	grasses, barberry, cattails, willows, mountain mahogany, Gambel's oak	boxelder, barberry, cliffbush, Douglas fir, Gamble's oak	grasses, clematis, yellow pine	grasses *(Poa)* currants, yellow pine

mainly to determine the efficacy of one or two days versus longer trapping periods. The winter, spring and early summer trapping was established at two sets of three days each (except for one period when pitfalls were accidentally left for four days). Catch numbers were adjusted (multiplying or reducing numbers actually caught) to make them all as though six days of trapping had been done at each site each season. Although this adjustment is not statistically valid or as valid as if all data had been collected the same number of days, it is more comparable than actual numbers since sampling times did vary. I did not know before making the samples whether the number of specimens would be too great for identifying and counting in a reasonable period of time. Also, too few samples might easily be too small to generate any dependable data if they were too variable, for example. The results will show my conclusions about these methods.

The animals from a bottle at a single pitfall were examined with a dissecting microscope. Each specimen was identified to species, or genus in some immatures, and the number of individuals for each taxon enumerated. I identified most of them but sent various groups with which I was not sufficiently familiar to the specialists indicated. Some have still not been identified as to species and there was one new species (Millidge 1981), and several others not yet described. Micryphantids and small linyphiids were not all identified to species and exact records as to site and season were not kept because so many were unidentifiable immatures or females. Voucher specimens of most species collected have been deposited in the general collection of the American Museum of Natural History.

The following data were recorded and/or calculated: numbers of species, numbers of individuals, sex, frequency of occurrence (Ashby 1935, Cox 1967, Curtis and McIntosh 1950), relative density (Cox 1967), site of occurrence and season of occurrence. Most of these terms are self-explanatory or in common usage and will not be defined. A few terms unique to this study, or which are not always used uniformly, are the following:

The mean number of individuals, or species, per site per three days of pitfall use have been recorded (or calculated) from the data. Various factors of the environment, mainly climatic (rainfall, temperature, wind, etc.) were seldom the same from day to day. Therefore, as shown by the two sets of three day samples taken successively, the samples were seldom without great variability.

Frequency (or percent frequency) is a widely-used easily determined ecological statistic which is commonly defined, and so used here, as the percent of the samples in which a species is found (Cain 1932, Cox 1967, Hoel 1943, McGinnies 1934). However, it is a poorer statistic than most because it depends upon a number of factors such as size of the organism, size of the sample, number of samples taken, density of the population, etc., instead of only a single factor such as density (number of individuals) or dominance (size, weight, volume or the like of individuals). Specifically in pitfall trapping there is the problem of the length of time a pitfall is in operation at any one period of sampling. In addition there is the problem of whether there are enough samples to get a "true" statistic representing the ubiquity of the population being sampled. The less common species, more so than the common ubiquitous species, will have larger frequencies if the sample is in operation for a longer period of time because that gives the individual of the population a longer time to fall into a trap. I know of no way to determine the amount of time a trap should operate to give a "true" value for that population's "actual" frequency.

Theoretically, the larger the frequency the more widespread and/or common a species is. To be an adequate sample of the actual population the number of pitfalls in use must be large enough to sample the less ubiquitous species as well as the wide ranging species.

What skewness occurs in this sampling is on the side of making frequencies lower than they would actually be if a larger number of samples had been taken. One way to judge the adequacy of the sample is to determine the distribution of species according to Preston's octaves of abundance (Preston 1948). When these data are plotted, it is apparent that there are too few rare species (those represented by one or a few individuals) as well as not enough individuals of common species, those with large numbers of individuals. This is aside from the environmental affects upon the community. Many more samples would give a more nearly complete sampling of the total species in the community. Nevertheless, a number of the common species have frequencies that are above 20% which has been determined to be an adequate percentage for most of the calculations (Ashby 1935, Cox 1967, McGinnies 1934, Morris 1960). However, this statistic is less reliable than others used here.

Relative densities (RD) are percentages (also called relative abundance. Uetz and Unzicker 1975) that indicate the proportion of the catch (pitfall, or group of pitfalls) that consists of a certain species (Cox 1967). The number of individuals of each species in the catch is divided by the total number of individuals of all species and multiplied by 100. Ideally, and theoretically, this is proportional to the actual numbers of individuals of the species in the total community but it is affected by the mobility, or nomadism of the species in the total community, the weather (Lowrie 1971), size, number and placement of samples, and other factors. However, it is one of the best statistics available and at least is more valid in comparing species abundance in a single study, like this, where samples are all the same, taken in the same way.

Catch (or sample) is used here for the number of species, or individuals, collected in a sample (pitfall or group of pitfalls). The community of spiders is used to encompass all the individuals and/or species caught in the pitfalls. The population of species inhabit a basically mixed coniferous forest with the plant species present as indicated in Table I.

Some of the limitations of sampling should be mentioned, as well as specific problems peculiar to this study. Immatures in most studies of invertebrates are difficult to identify and with spiders this is also a problem. However, in a specific localized area when many adults have been captured and there are no, or few closely related species, the immatures of that genus are the species which has been identified by the adults.

The pitfall technique, as has not been too clearly or generally emphasized in the literature, samples only moving individuals. It seems better than the quadrat method for sampling this roving population (Uetz and Unzicker 1975). However, any stage of development of a species which is relatively sedentary will only rarely be sampled, so it does not sample roving and stationary ground species equally. Most ground level species probably do move at some time during their life cycle, although for each species these values would be different. They are certainly not trapped always in the same proportion that they occur in an area. This gives relative densities and numbers per pitfall that must be markedly different from, usually below, and at least not always in proportion to their actual numbers. Quadrat sampling can compensate for this to a great extent but the amount of field work necessary to get an equal amount of information is several times as great and in addition will not sample the tiny species very well unless it is combined with the Tullgren Funnel extraction or other methods.

Variability between samples is great. This is at least partly due to the differences in the weather (rain, snow, temperature and wind mainly) on the sampling days. These data from this preliminary sampling show that this variability can be smoothed out or dampened by more days of sampling at any one sampling period. The two sets of three day samples or the three sets with a total of nine days of sampling in this study give better, more nearly average representative counts of the wandering spiders of an area than a short, one or two day, sample.

Finally, there is probably a lack of sampling of some species and " overcatching" of others because their vision allows them to avoid the trap or they may be attracted to it as a possible retreat to avoid rigorous weather, predators, or other features of the environment. However, there is no way to determine the extent of these effects on numbers caught—it must simply be recognized that the sampling is biased.

RESULTS AND DISCUSSION

Frequency and Relative Density.—Spiders average nearly 10% of the invertebrate mobile ground populations of Mortandad Canyon for the entire year.

Relative density figures show that Acarina had an RD of 35%, Collembola 28%, Formicidae 17%, Diptera 3.6%, Coleoptera 2.4%, Homoptera 1.8%, Heteroptera 1%, Thysanoptera 0.9%, Hymenoptera (mainly wasps) 0.8%, Orthoptera 0.5% and the remaining insects (Psocoptera, Lepidoptera, Thysanura, Mecoptera, Neuroptera, Siphonaptera) the remaining 1%.

In considering the spiders as a whole, we find the following frequencies and relative densities by sites and seasons (Table 2). Although the relative densities are low the frequencies are quite high most of the year. In other words, spiders are found in most of the pitfalls most of the time, that is, spiders are quite ubiquitous. Throughout the year they are found in 85% of the pitfalls. Late winter occurrence was significantly lower than any other time with a mean frequency of 55%. At other seasons all four sites had similar frequencies.

Early summer contrasted markedly with winter in that every pitfall had at least one spider (frequency 100%). This is true even if the great number of active males of *Pardosa yavapa* which were in their courtship stage of life, searching for females, were eliminated form the analysis. Eliminating this species could only change two sets of pitfalls dropping the F to 90%. Midspring was also high with a mean of 94%. The other seasons were lower but high also.

The frequency of finding spiders at each site was high and about equal each season although winter, as might be expected, was lower. The relative density of spiders fluctuated much more than did the frequency (Table 2). Relative densities for spiders ranged from a low of 2.4% in winter at Site I (they were a small proportion of the total community) to a high of 25% at Site II in early summer, nearly eleven times as great. However, this high value is greatly inflated since over 75% of the catch was of the one species, *Pardosa yavapa,* most of which were males in search of females with sex, not food, as the stimulus for movement.

I am at a loss to explain these data as far as density analyses are concerned because of the large number of *P. yavapa.* Similar increases in abundances of some other species probably occur at mating time although not in all species to the same degree. It is possible also that the absolute density of this species is greater than that of any others in this community but this one set of early summer samples can only hint at such a possibility. More extensive sampling seems called for to better analyze this species' abundance and its relationship to the other species in the community.

Table 2.–Spider distributions by seasons and sites (for six trap days).

		Sites					
		I	II	III	IV	Mean	Total
Late	No. of species	6	4	6	16	8	25
Winter	No. of individuals	13.7	6.9	22.0	59	25	101.6
	% Mean frequency	50	50	50	85	59	
	% Mean relative density	1.4	3	0.8	2.6	1.9	
Mid	No. of species	13	11	16	26	16.5	30
Spring	No. of individuals	70	45	89	53	64	257
	% Mean frequency	100	90	100	85	94	
	% Mean relative density	8.6	5	4.75	3.05	5.4	
Early	No. of species	19	19	22	26	21.5	45
Summer	No. of individuals	242	418	319	161	285	1140
	% Mean frequency	100	100	100	100	100	
	% Mean relative density	15.3	25.45	14.45	7.95	15.8	
Mid	No. of species	18	15	10	14	14.25	32
Summer	No. of individuals	60	43	25	81	52	209
	% Mean frequency	87	83	71	93	84	
	% Mean relative density	12.4	10.2	4.35	9.3	9.5	
Mid	No. of species	9	12	8	11	10	21
Fall	No. of individuals	43	41	61	57	50.5	202
	% Mean frequency	83	90	87	93	88	
	% Mean relative density	11.1	7.5	11.9	2.1	8.1	
Yearly	No. of species	31	32	26	43	33	78
Means	Mean no. of species	13.0	12.2	12.4	18.6	14	
and	No. of individuals	429	554	516	411	476	1910
Totals	Mean no. of Individuals per site	85.8	111	103	82	95-97	382
	% Mean frequency	84	83	82	91	85	
	% Mean relative density	9.8	10.2	7.25	5.0	8.1	

The mean yearly RDs of spiders at Sites I, II and III were 7% to 10% whereas at IV the RD was only about half that, 5%. The variability in relative density from site to site and season to season was similar. Sites I and II were about twice as high in RD as III and IV. Most seasons showed lowest RDs about half that of the highest, except in midfall.

Statistically significant relative densities between sites and seasons were few as determined by using the arc-sine conversion of RD figures. However, there is no clear trend or clue as to what the causes of these differences might be (and for this reason I'm not presenting these data). There were significantly higher RDs for early summer, but definite conclusions must be avoided at this time because they are due to the larger number of *Pardosa yavapa* as indicated earlier. All other seasons are not statistically significantly different from one another. More samples at each site might show significant differences. At present it would seem that the only certain conclusion is that the relative density of spiders in winter is significantly low while for the rest of the seasons the proportion of the community that is spiders remains high and about the same.

The RDs of spiders and the actual numbers of all invertebrates (all potential prey) per pitfall or site are related as follows. Discounting early summer for the reasons already noted, only Site IV shows RDs that are significantly lower from season to season. When more than about 50 individuals invertebrates are collected in a pitfall the RDs of spiders are usually less than 10%. Conversely, when spider RDs are high (more than 20%) then the numbers of individuals per pitfall are less than about 40. This is not applicable to the early summer figures. The added numbers of male *P. yavapa* produce higher RDs. When both values (numbers of individual invertebrates and RD of spiders) are low there are neither positive nor negative correlations. And, finally, there are no cases where numbers of individuals and RDs are both high. This seems to mean that when the numbers of individuals of all species in the environment are high, then the numbers of spiders are not increasing as rapidly to avail themselves of the added prey. Conversely, when the proportion of spiders is high it might be because the prey have died and left proportionately more spiders alive. This condition applies (except for the unusual summer condition) almost exclusively during midfall (about 20 pitfalls out of the 120 censused). Only five of nearly 200 pitfalls produced over 25% RD (except for early summer).

Finally it must be acknowledged that these are possible conclusions only as many prey species were probably not sampled in the pitfalls and features such as life cycle durations and mobility patterns of the insects and spiders were not known or taken into consideration. The collecting may average out differences or even skew them one way or another, but I present them here as giving some evidence that predator-prey relationships may show the lag indicated, and should be investigated in any subsequent study of this sort.

Numbers of Individuals.—In this discussion I am eliminating the early summer collections (Table 3). The number of individuals for that period is significantly higher than for any of the other collecting periods. But this is due to the large number of *Pardosa yavapa.* Of 1140 individuals collected during this period, 819 were *P. yavapa,* and over 80% of these were males. Collecting was apparently done at or near the peak of their period of search for females. This was corroborated by some collecting done at the same time the following year, although the numbers were only about half as large.

Finally, I am not considering this summer collection in detail also because it was taken at the beginning of the summer season and comparable collections at the beginning of each season were not made. Although it was a valid collection in general it seems to me that because of these factors (including the overwhelming numbers of *P. yavapa*) it is reasonable to consider these data as atypical. I will only point to the actual figures and not compare them with the other collection figures.

In general the number of individual spiders per pitfall, regardless of the species, was low. Means ranged from 0.4 spiders per trap to 4.45 while actual numbers went as high as 13. Finally, only 34 of 379 traps for the year had six or more spiders in them. The overall mean for the four seasons was 2.5 spiders per pitfall. The data in Table 2 indicates that few of the pitfall means were different from one another, except for the winter sampling

Table 3.—Number of individuals of *Pardosa yavapa* (adjusted to 10 traps totals for six days).

	Sites				
	I	II	III	IV	Season Total
Late Winter	0	0	0	1	1
Midspring	27	4	8	7	46
Early Summer	177	362	184	99	822
Midsummer	4.5	0	0	11.3	15.8
Midfall	.7	0	0	7.3	8
Totals	209.2	366	192	125.6	892.8

at Sites I, II and III. Some were statistically significant, but no trend is obvious enough to make the data reportable. They were all significantly lower in spider catches from nearly all other sites and seasons of collecting (except early summer).

Dispersion of Spiders.—An attempt was made to determine whether the spiders were dispersed in a random, clumped or uniform fashion (Cole 1945). Using analyses relative to the Poisson distribution (variance equal to the mean in randomly dispersed populations and variance greater than the mean in clumped populations) all seasons show clumped figures. Even when considering one set of pitfalls placed at a site for one, three or five days only three samples of ten pitfalls showed a dispersion that was not clumped.

All indications in this study are that the spiders are dispersed in a somewhat clumped fashion. The difference in conclusions between this analysis and Cole's is presumable due to the differences in the habitat. The wooded area in which Cole sampled was a rather homogeneous habitat without marked differences in moisture, litter, temperature or other ecological factors to which the spiders might react. Although each of the sites in Mortandad Canyon did not have a great deal of difference between pitfalls, nevertheless, there were differences in moisture, temperature due to insolation, degree of shade, etc. These were probably enough to cause spiders to aggregate in certain pitfalls and not so much in others. This created a tendency to clump because of the environment and not because of the behavior of the spiders to the presence of other spiders (or other small carnivores) and/or prey.

Number of Species.—The total number of species of spiders collected at a site seasonally ranged from four (late winter at Site II) to 26 (early summer at Site IV–Table 2), about seven times as great. During any season the differences between sites were not as great, ranging from four to only 1.4 times as many species at the site with the greatest number of species as the one with the least number. This means that there were about the same number of active species at any of the sites at any particular season.

The greatest variation in numbers of species is seasonal. Site II and III show the greatest variation with early summer showing between four and five times as many species as the low winter numbers. Site IV is more uniform, with numbers of species varying from a low of eleven to a high of 26, only 2.4 times as great. (This mean number of species per season per site varied from eight in late winter to 2.7 times as great (21.5) in early summer). Consistent with this is the fact that the range in total numbers of species collected at all sites per season was also great, varying from 21 in midfall to 45 (2.14 times as many) in early summer.

Site IV has the greatest variety of species; more species occurred there in most seasons than at any other site. From a general assessment of the sites this would seem due to the site being less extreme, or at least less variable, in temperature, precipitation and moisture. The site would seem to have a greater variety of microhabitats also. Both the total number of species found here (43) and the mean number per six pitfall days (19) was over 1.5 times as great as at the lowest site (Site III). At the same time the community of spiders at Site IV was more stable, showed less variation in numbers, than at the other sites. This generally coincides with our knowledge of more complex communities such as rain forests versus less complex communities such as deserts and tundra. It is also an expression of the fact that the physicochemical parts of the environment (temperature, winds, humidity, moisture, etc.) are more variable and affect the biotic community more in a less protected environment than in a more complex community in which the biotic affects control the organisms mostly (Odum 1971).

Seasonally, the late winter is most variable in number of species (from site to site: four to 16) whereas summer is least variable (14 to 26). Mean seasonal variations are of greater magnitude (eight to 21.5—seven times greater) than mean site variations (26 to 43—1.65 times greater). Only winter shows a range between sites (four times as great) that is greater than the magnitude of the range between seasons (eight to 21.5—only 2.7 times as great). This again illustrates the possibility that physicochemical factors control the environment in winter.

In summary, the range in numbers of species between sites was never great at any one season except in late winter. That is, at any season but winter, the number of species at each site was not significantly different.

Phenology—Seasonal Distribution.—The patterns of seasonal activity shown by the common species (Appendix) are as follows. Only *Hahnia cinerea* is active equally, or nearly so, at all seasons. Most species are active in spring, often in greater numbers at certain sites. *Pardosa yavapa* is abundant at all sites in early summer but significantly less so at IV and with a definite preference for site I. *Agroeca pratensis* is more common at Sites I and III whereas *Zelotes subterraneus* is more common at III and IV. In terms of the moisture gradient the *Cicurina* and the *Gnaphosa* may be tolerant of a wide range of moisture whereas *P. yavapa* and the *Agroeca* prefer moist sites.

Most common species show preference for two sites rather than a single site. The following distributions can be inferred from this study, but only future replication can establish them as true consistent generalizations for the species involved. *Pardosa sierra,* a typical streamside species (Lowrie 1973) and *Hahnia cinerea* prefer Sites I and II. *Titanoeca silvicola* and *Micaria montana* are more abundant at Sites II and III and *Neoantistea gosiuta* at Sites III and IV. *Schizocosa mccooki* and *Trochosa gosiuta* show a strange abundance at the extremes, I and IV. What the explanation of this is cannot be determined for certain but does seem to correlate with the species preference for drier habitats: Site I does have some dry areas. Only one genus, *Haplodrassus,* is commonly at one site only, III. The two species of the genus do occur at other sites but only as one or two individuals. However, this may be an artifact of collecting and identifying as most specimens were immature, or it may be just the situation this year.

At each site we can say there are about the same number of common species. It is suggested that this may be due to the carnivorous habits of spiders and the tendency for carnivores to be evenly or randomly distributed (Cole 1945), in a uniform habitat.

A cluster analysis of the common spiders at each site was also done, but not presented here because no significance can be attributed to it since they were not consistent and no field data or information on the species would give a reason for such correlations. Seventeen species of spiders were involved with an unweighted pair-group method used to produce a dendrogram. This dendrogram showed Sites I and II to be very similar and Sites III and IV likewise, with a greater distance between II and III. This could fit in with the evaluation of the situation from year long observation although other evaluations may be equally plausible, such as that Site I is different from II and III, and III is different from IV or I. There is little justification for any conclusion of differences between sites. A much more extensive and intensive sampling would be necessary to determine whether there were any differences.

CONCLUSIONS AND SUMMARY

1. Spiders constitute about 8% of the wandering streamside ground-inhabiting invertebrates of this mixed-conifer biotic community, in Mortandad Canyon.

2. Spiders' frequency of occurrence (measure of their ubiquity) is high with a mean for the year of 85%, winter was significantly low (59%) and summer was high (100%).

3. Spiders occurred about equally at the four sites with frequencies from 82% to 91% for the year. Site IV showed higher frequencies than other sites, but in light of the unreliability of this statistic do not seem to warrant conclusion of a difference at Site IV from this study.

4. The mean relative densities of spiders were low, ranging from less than 2% (late winter) of the invertebrate population to over 15% (early summer). Their relative densities were highest (about 10%) at Sites I and II and lowest (5%) at Site IV.

5. At Site IV the RDs were most stable (varied less) throughout the year (2.1% to 9.3%). Site III was most variable ranging from a low of 0.8% to a high of 14.45%. The seasonal shift in relative densities of spiders indicates that this carnivorous population increases proportionately more than its prey population from winter into summer. It then regresses during the rest of the year to a low proportion when prey seems to be correspondingly low.

6. The actual densities of spiders (the numbers of individuals per pitfall or site) throughout the year were about equal at each of the sites (low mean of 82 individuals per site at IV to a high mean of 111 at Site II). Seasonally, their abundance ranged from a total of 102 individuals from all four sites in late winter to over 200 in the other seasons, with a high in early summer of 1140. Thus densities were lowest in late winter (mean of 25 individuals per site) increasing to a high in early summer (mean of 285 individuals per site) and then back down to a low in winter.

7. The mean numbers of species per season range from eight per site in winter to nearly 22 per site in early summer and then declined to the near low of ten in midfall. There was an overall mean of 14 species per site for the year. The mean number of species per site for the year ranged from lows slightly over 12 at the 3 higher sites to a high of 19 species at IV. The number of species (species diversity) was greatest at Site IV most of the year, and was more variable at the other sites.

8. The dispersion of spiders was clumped. This may be due to the habitats being relatively heterogeneous with a variety of micro-environments although no analysis of this factor was made. If that is the case then the spiders would clump in microhabitats that they prefer, and avoid those not suitable.

9. This study shows no effect of the contaminating radionuclides introduced into the stream at Site II. That is, the sites of contamination did not show significantly greater or fewer numbers of individuals, number of species, relative densities, frequencies or other measurements than any other site. It is concluded that this study shows no effect of the radioactive material on the spider population.

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Appendix

Wandering Spiders of Mortandad Canyon collected in pitfalls. Numbers for commonest species (more than 10 specimens) in parentheses: 1 = Rank (16 most common), 2 = Number of individuals captured.

Agelenidae	1. *Cicurina robusta* Simon (4 - 60)
Amaurobiidae	2. *Titanoeca silvicola* Chamberlin and Ivie (10 - 20)
Anyphaenidae	3. *Anyphaena marginalis* (Banks)
	4. *A. pacifica* (Banks)
Clubionidae	5. *Agroeca pratensis* Emerton (2 - 142)
	6. *Castianeira cingulata* (C. L. Koch)
	7. *C. descripta* (Hentz)
	8. *Clubiona* sp?
	9. *Phrurotimpus* nr. *woodburyi* Chamberlin and Gertsch
	10. *Trachelas deceptus* Banks
Dictynidae	11. *Dictyna apacheca* Chamberlin and Ivie
	12. *D. completa* Chamberlin and Gertsch
	13. *D. terrestris* Emerton
Gnaphosidae	14. *Callilepis eremella* Chamberlin
	15. *Drassodes neglectus* Keyserling
	16. *Drassylus* nr. *argilus* Chamberlin
	17. *Gnaphosa muscorum* (L. Koch) (12 - 14)
	18. *Haplodrassus chamberlini* Platnick and Shadab
	19. *Haplodrassus bicornis* (Emerton) (11 -17)
	20. *Micaria montana* Emerton (3 - 98)
	21. *Nodocion* nr. *florissantus* (Chamberlin)
	22. *Zelotes subterraneus* (C. L. Koch) (5 - 57)
Hahniidae	23. *Hahnia cinerea* Emerton (7 - 42)
	24. *Neoantistea gosiuta* Gertsch (16 - 11)
Linyphiidae	25. *Helophora* sp?
	26. *Lepthyphantes subalpina* Emerton
	27. *Lepthyphantes* sp?
	28. - 31. *Meioneta* sp?
	32. *Neriene radiata* (Walckenaer)
	33. *Wubana drassoides* (Emerton)
Lycosidae	34. *Arctosa* sp?
	35. *Pardosa montgomeryi* Gertsch
	36. *P. orophila* Gertsch
	37. *P. sierra* Banks (13 - 12)
	38. *P. sternalis* (Thorell)
	39. *P. yavapa* Chamberlin (1- 919)
	40. *Schizocosa mccooki* (Montgomery) (9 - 21)
	41. *Alopecosa kochi* (Keyserling)
	42. *Trochosa gosiuta* (Chamberlin) (6 - 47)
Micryphantidae	43. *Ceraticelus crassiceps* (Chamberlin and Ivie)
	44. *Ceraticelus* sp?
	45. *Ceratinella* sp?
	46. *Ceratinops* n. sp.
	47. *Collinsia perplexa* (Keyserling)
	48. *C. plumosa* (Emerton)
	49. *Disembolus anguineus* Millidge

	50. *Eperigone taibo* Chamberlin and Ivie
	51. *E. trilobata* (Emerton)
	52. *Eperigone* sp?
	53. *Grammonota gentilis* Banks
	54. *Islandiana flaveola* (Banks)
	55. *Pocadicnemis pumila* (Blackwell) (8 - 22)
	56. *Spirembolus pallidus* Chamberlin and Ivie (14 - 14)
	57. *S. vallicolens* Chamberlin
	58. *Walckenaera directa* (O. P.-Cambridge)
	59. *W. spiralis* (Emerton (15 - 12)
	60. *Walckenaera* n. sp.
	61. - 63. Three species not placed as to genus
Oonopidae	64. *Orchestina saltitans* Banks
Philodromidae	65. *Thanatus coloradensis* Keyserling
	66. *T. formicinus* Clerck
Pholcidae	67. *Pholocophora americana* Banks
	68. *Psilochorus imitatus* Gertsch and Mulaik
Salticidae	69. *Pellenes* sp?
Tetragnathidae	70. *Tetragnatha laboriosa* Hentz
Theridiidae	71. *Euryopes* sp?
	72. *Theridion murarium* Emerton
Thomisidae	73. *Ozyptila sincera canadensis* Dondale and Redner
	74. *Misumenops* or *Misumenoides* sp?